Description of surficial deposits map units

Description of bedrock lithology Suitability for construction Special problems Susceptibilty to frost action Topography and drainage Permatrost Distribution and thickness Description of materials symbol and Upper-and lower-case map symbols listed in column at left edge of table; lower-case map symbols explained in adjoining Description of Surficial Glacial streams and Tazlina Lake subject to Deposits Map Units. Sources of information listed at bottom of each column. Except for flood hazard due to spring runoff and Water-washed and deposited boulder, cobble, and Permafrost may be present locally in silty overburden Generally not frost-susceptible except for silt Form narrow to broad incised floodplain and low-Distributed in floodplain and low terraces of major summer glacier discharge, gravel of floodplain pebble gravel, sand, and silt, with local organic of terraces, but generally appears absent in coarsestream systems, including broad outwash plains in terrace surfaces as high as 15 to 20 ft (5 - 6 m) above 5 ft (2 m) due to hot-weather glacier discharge provides level ground and good near-surface materials; he river, principally along Nelchina, Little Nelchina, alluvium to more than 6% and for isolated grained fluvial deposits that are warmed by heat material. Forms lenses and thin to thick beds; local however, borings should be drilled to check presence or lakes such as Tazlina Lake. Thickness of alluvium condition from bodies of surface water and by occurrences where disintegrating shale clasts Flood-plain and low-terrace alluvium imbricate structure. Large boulders and other Tazlina, and uppermost forks of Matanuska River, and contain coal and chert; in some areas it absence of liquefiable saturated sand and silt and convection from moving ground water discharging to material winnowed from glacial and glaciolacustrin Tyone Creek. Incised valleys bordered by low to high contains shale clasts that cause failure of South of Glenn Highway and west of South South of Glenn Highway between South Fork South of Glenn Highway between Nelchina South of Glenn Highway and east of Tazlina North of Glenn Highway under downcutting streams in canyons probably less deposits through which canyons have been cut; bedrock than 23 ft (7 m), as modern paleo stream scour. colluvial slopes and sheer bedrock bluffs. Alluvial the stream. No subsurface data available. suitability tests for concrete aggregate. Matanuska River and Nelchina Glacier and Glacier and River and Tazlina Lake and Lake and Glacier Unit to flood and also suitable for construction; local source Fork Matanuska River slabs and boulders added to stream deposits by lateral Thickness may be greater in outwash plain and in fansurfaces well drained, but subject to river flooding at a recurrence interval ranging from about 1 in 2 years on sandy foreset and silty bottomset beds. isintergrate rapidly to form silty angular pebbly lowest surface to a much greater interval on terraces: matrix for gravel. In general, however, sandy matrix floods along Tazlina Lake and River from Nelchina and Undifferentiated siltstone, sandstone, and Undifferentiated siltstone and sandstone Not present. Undifferentiated siltstone, sandstone, and contains less than 6% silt sized material. deposits l'azlina Glacier discharge are much as 5 ft (2 m) above normal lake level and perhaps triple generally coarser upstream, near glacier sources. Includes basal conglomerate and overlying Chiefly pebbly sandstone of Cretaceous age onglomerate and sandstone of Talkectna Not present. Channel sandstone and conglomerate of and siltstone, sandstone, conglomerate and formation and terrestrial conglomerate and Cretaceous age, outlet Tazlina Lake. sandstone beds and lenses of Cretaceous age: Permafrost probably present in high terraces along Generally not frost-susceptible except for silty Terraces bordering modern streams generally more than 15 ft (5 m) high, broken by tributary gullies; Water-worked and deposited boulder, cobble and Forms terraces along stream courses generally above carbonaceous conglomerate of Tertiary age. sandstone of Chickaloon and coal bearing vegetation overburden than lower terraces, and modern streams, but sporadic in distribution. Permafrost may be absent to sporadic beneath former pebble gravel, sand, and silt, with local organic flood level; covered by silty organic soils that suppor greater chance for frozen ground, in deposits along concretions of Tuxedni formation; fluviatile material to more than 6%. naterial. Forms lenses and thin to thick beds; local mature spruce forest with heavy moss cover. Deposit locally covered by fan or colluvial deposits along bluff conglomerate and locally coaly sandstone of river: the higher terraces offer gullied sites havin outwash channel systems which are seasonal stream generally as thick as maximum depth of scour - 23 f Terrace, deltaic, and outwash deposits imbricate structure. Large boulders and other at valley margin. Well to poorly drained in thick moss, material winnowed from glacial and glaciolacustrine courses and discharge areas for ground water, and 7 m) on major streams; deposits on former deltas may silt mantle, and dense woods. Abandoned deltas and and water. Other sites in former outwash plains and beneath the well-drained old deltaic deposits. Ground deposits through which the streams cut to deposit be 10 ft. (3 m) thick and lie above sandy foreset beds outwash channel terraces deposits, by contrast, are deltas have excellent topography, materials, and water alluvium, Generally less than 6% silt, except for local Volcanic wacke and sandstone of Talkeetna Chiefly volcanic sandstone of Talkeetna Chiefly sandstone, some shale, siliceous Sandstone, lesser shale and siltstone, and silty bottomset beds. Former outwash deposits o ice settlement problems unlikely in these granular formation and sandstone of Matanuska shale, and siltstone of lower part of siliceous shale and zeolitized sandstone; Formation.

Matanuska Formation; also sandstone of limestone beds. It lenses and beds; contains local concentrations of braided channels apparently only 10-15 ft (3-4.5 m) have a generally higher water table than the terraces oversize material; generally becomes finer bordering streams. Jurassic Chinitna Formation and Naknek thick at most and lie on till. downstream in former fluvial and outwash terraces; becomes finer at depth in former deltaic deposits. Cretaceous age. Minor shale and pebbly Chiefly siltstone, locally containing Mudstone, marine shale, siltstone, local thin layered chert, calcareous concretions; minor Siltstone, claystone of upper part Matanuska Formation, some sandstone with lenses of sandstone and conglomerate. Rounded to subangular, well sorted, accumulation of Forms single to multiple elongate beach ridges less than 10 ft $(3\ m)$ high and individually about 15 ft $(5\ m)$ Principally found along shoreline about 2,450 ft (747 for road or airfield alignment or for providing extent to be considered for major construction sites, occupied by beach deposits, but may occur at greater pebbles and cobbles as large as 1 inch (3 cm) in m) above sea level marking one of the last major lake small amounts of borrow. However, it is suitable to excellent foundation and sandstone conglomerate; local cone in cone stands with a semi-stable outlet. Deposit is seldom as depth in local areas. beds; minor sandstone and conglomerate. sandstone and conglomerate. across, though they do occur in groups aggregating 330 lenses and beds of sandstone and Beach deposits drainage for small sites, with modest amounts of clean Commonly rests on or grades into wave-winnowe wide as 330ft (100 m) across series of beach ridges, ft (100 m) in width. Deposit is well drained and Commonly claystone or marine shale. conglomerate. siltstone and claystone; local graded sandstone beds. Rocks of Jurassic and and is more commonly a single poorly-developed beac underlying till; may merge laterally to lag boulders at ridge, 6-10 ft (2-3 m) high, and containing, perhaps 6 ft aspen and other forms of dry land vegetation. Not present. Not present. Neichina limestone (calcarenite) Unstable slopes require special design or Generally not suitable for construction because of No information on permafrost, other than speculation Mixed silt, sand, gravel, and broken rock derived by Largely concentrated along base of river bluffs and Localized on lower third of slopes of river bluffs and Locally contains more than 6% silt which when steep slopes, poor materials, local seepage sites for Andesite, andesite and dacite, basaltic and volcanic rocks, tuffaceous and esite or undifferentiated intermediate and volcaniclastic sediments, of basalt or and marine and nonmarine volcanogenic and marine and nonmarine volcanogenic gullying, mudflow activity, creep, and landsliding that that it is probably present, particularly on shaded ground-water discharge (winter icings), and, include cones, fans, creep deposits, and landslides too other breaks in slope, and extend out onto adjacent Lavas and pyroclastic rocks of intermediate small to map individually. Thickness less than 33 ft stabilized north-facing slopes, and to a lesser extent plains at base of slope. Relief is uneven reflecting eomposition; sandstone and argalite dominantly marine; largely falkeetna particularly because of active slope movement, such as (10 m), wedging out to upslope boundary and lavas and pyroclastic rocks, with minor metabasalt; Talkeetna Formation. the bluffs. Generally non stratified to poorly or landslide, gravity, and mudflow and rill-forming gully sedimentary rocks; Talkeetna Formation. landsliding, soil creep, and gullying. action. Unit drains at a steep gradient downslope irregularly stratified; locally mixed with organic irregularly thinning downslope to toe of unit, marine sandstone and argillite; Talkeetna through gully or rill system; rapid runoff. Soils dry and well drained in some places, wet and plastic in slumps Andesite and tuff, lithic tuff (predominantly Ignimbrite (a consolidated ash flow or nuce Included within Vu unit. Not present. material other than pyroclastics), and crystal ardente deposit); layered welded pyroclastic; little tuft (non-pyroclastic material medium to well compacted fine to very Fair to poor for construction because of fine-grained Probably not susceptible to frost action because Growth of aspen and dry soils suggest that no Forms low, linear ridge along top of bluff. Drainage Localized along tops of bluffs bordering incised rivers foundations and borrow limited on site to sand or silty coarse grained water-laid tuff with angular Stratified coarse to fine sand, sandy silt, and silt, permafrost occurs within the eolian deposits, except usually the south facing bluff where winds off the excellent at summit, but poor on side away from bluf sand. Risk in location adjacent to steep bluffs, which fragments. In thin layers; locally sandy, although locally silty. or the possibility of some minor shallow permafrost Chugach Mountains have blown up over the cliffs to face, where drainage is ponded. are locally subject to erosion by river and gullying. hydrothermally altered. Eollan deposits on the slopes away from the bluff face. form cliffhead dunes. Deposit generally less than 10 ft Site is dusty as material is blown up over cliff. (3 m) thick, but may reach as much as 33 ft (10 m) Terrain broken by ridges amd deep gullies. Quartz diorite and tonalite, locally sheared Felsic to andestic untermediate) plugs and Felsic to intermediate plutonic rocks, include Biotite-epidote grante, medium grained and Plugs and dikes of feldspar porphyry and of (where dotted on map); felsic intrusives such as quartz porphyry; and some intermediate containing plagic lase, quartz, hornblende dikes, sills, and small stocks that are mostly dacite and larger bodies of biotite hornblende granodiorite; minor quartz porphyry; medium-to coarse-grainer dacite and larger bodies of biotite hornblende granodiorite; minor quartz porphyry; medium-to coarse-grainer dacite and larger bodies of biotite hornblende granodiorite; minor quartz porphyry; medium-to coarse-grainer dacite and larger bodies of biotite hornblende granodiorite; minor quartz porphyry; medium-to coarse-grainer dacite and larger bodies of biotite hornblende granodiorite; minor quartz porphyry; medium-to coarse-grainer dacite and larger bodies of biotite hornblende granodiorite; minor quartz porphyry; medium-to coarse-grainer dacite and larger bodies of biotite hornblende granodiorite; minor quartz porphyry; medium-to coarse-grainer dacite and larger bodies of biotite hornblende granodiorite; minor quartz porphyry; medium-to coarse-grainer dacite and larger bodies of biotite hornblende granodiorite; minor quartz porphyry; medium-to coarse-grainer dacite and larger bodies of biotite hornblende granodiorite; minor quartz porphyry; medium-to coarse-grainer dacite and larger bodies of biotite hornblende granodiorite; minor quartz porphyry; medium-to coarse-grainer dacite and larger bodies of biotite hornblende granodiorite; minor quartz porphyry; minor quartz porphyry; medium-to coarse-grainer dacite and larger bodies of biotite hornblende granodiorite; minor quartz porphyry; medium-to coarse-grainer dacite and larger bodies of biotite hornblende granodiorite; minor quartz porphyry; minor quartz porphyry; medium-to coarse-grainer dacite and larger bodies of biotite hornblende granodiorite; minor quartz porphyry; minor hypabyssal rocks of intermediate plutonic rocks or mixed mafic and felsic and biotite; locally intruded by sheeted mafic hornblende granodiorite. Shifting stream channels; mudflow and potential Construction limited by steep slopes and shifting dikes as thick as three meters. Susceptible to frost action where silt content Permafrost probably discontinuous, and more likely to avalanche hazard. In plan, a triangular or fan-shaped map unit, with apex Chiefly angular to subrounded gravel of rock type stream channels; generally dry, firm foundations with eastern and southern front of Talkeetna Mountains and be prevalent and thickest in toe area where drainage is extending up lower third of hillside, and remainder in mapped upslope from upper end of fan; matrix sandy, especially in the toe of many fans; coarser silt-Gabbronorite, fine-coarse textured, sheared Gabbro, coarse to medium, sheared (where Mafic plutonic complex, includes layered Mafic plutonic complex, includes layered Not present. along major valleys within these mountains. Thickness poor and ground-water circulation lower than other borrow are favorable in all except wet toe area of fans slightly silty; boulders to granules. Poorly stratified free gravel not subject to frost action. Alluvial-fan deposits unknown, but probably generally less than 33 ft (10 m), areas of coarser materials and higher ground-water hornblende-pyroxene gabbro and leucogabbro, perhaps 10 - 20 ft (3-6 m) local relief at stream (where dotted on map); diorite and dotted on map), pyroxenite, horblendite, where soils are fine grained. Care should be taken to and more poorly sorted than al and at. minor ultramafic bodies, diorite and minor ultramafic bodies, diorite and tonalite avoid areas of alpine mudflows indicated by leveetonalite/quartz diorite; pyroxenite; gabbro and quartz diorite (undifferentiated) ocally be in excess of void spaces of fine-grained pyroxene-hornblende gabbronorite with cut by basic and intermediate and by middle parts of unit, but finer material having very bordered stream courses and silty soils. tonalite. Layered quartz gabbro body is a low slope near toe is poorly drained and locally undifferentiated sheared intermediate and diabase/basalt dikes. large tectonic inclusion within McHugl amphibolite facies rocks and orthogneiss; has quartz and only minor hornblende. Banded Generally poorly to moderately well-suited for Silt content much greater than 6% causes high General topographic form is alternating low ridges and swales oriented as shown by drumlin symbol, in the Permafrost probably prevalent but thickness not Widely distributed in mountains and basins above 2,45 construction; limited by lack of granular borrow, Nonsorted, nonstratified, inhomogeneous mixture of degree of frost susceptibility wherever water is Body of serpentinized pyroxenite within Serpentinized pyroxenite. known; probably more than maximum recorded m) as surficial deposit, but below 2,460 ft (747 m) is commonly covered by thin lacustrine deposits Serpentinite. Not present. boulders, cobbles, pebbles, sand, silt, and some clay. thickness of 125 ft (38 m) locally. Thin or absent where ground temperature is affected by bodies of Not present. direction of ice movement. Net relief of 3 - 33 ft (1-Coarse material generally angular to subrounded. Well graded or poorly sorted; locally compact. Where a thin mafic plutonic complex near head of Bottley permafrost, poor soil drainage, and local hummocky 10 m) little modified by overlying lacustrine deposits (le/gm) although landforms retain features of ground moraine. Thickness of unit reaches about 50 ft (15 m), running or standing water. May contain ice-rich zones (where lc/gm). Drainage fair on ridge tops where slope Ground moraine (till) veneer, shown as gm/Yu, where overlying volcanic rocks; generally covered by lacustrine deposits that favorable for constructions. but locally it overlies other deposits, e.g. in thick is adequate to drain overland, but poor where level. Phyllite, locally chloritic, and thin bedded Schist, graywacke, quartz sericite albite Marine argillite, siltstone, sandstone, and Not present. sections along Nelchina River and Tazlina River. are shown as lc/gm. Crystalline glacier ice having a Not present. metagraywacke and metagreenstone beds and chlorite schist, graphitic. Also slow downvalley motion; buried by firn or perennial lenses. Grades westward into rocks more conglomerate, sandstone, and siltstone, metasedimentary rocks. Lenses and layers of volcaniclastic argillite altered to epidotesnow above about 4,500 ft (1,375 m), depending on l conditions. Carries entrained rock debris. amphibolite facies, locally gneissic; intruded weakly foliated greenstone with pillow Crystalline glacier ice having a slow downvalley

Distributed as neve fields and small ice caps that feed

Smooth appearing, gently sloping white, clear ice,

Glaciers below the firm line are melting and are being

Glaciers below the firm line are melting and are being locally by gabbro. motion; buried by firn or perennial snow at above about 450 ft (1375 m), depending upon local glaciers are perennially frozen and structures built on volume increase when water freezes. Mountains, e.g. South Fork Matanuska River glacier, Greenschist and blueschist as blocks in a Greenschist and blueschist as blocks in Not present. glacier, and by crevassed ice falls across the glacier. Not present Nelchina Glacier, Tazlina glacier, and the small alpine Marginal crevasses, lateral moraines and terminal mélange or as continuous belt extending mélange or a continuous belt northeastward conditons. Carries entrained rock debris. glaciers area boundary). Thickness of snow and ice not moraines mapped as mic where ice cored, moraines as northeastward from Nelchina Glacier. from Nelchina Glacier to Klutina Lake. known, probably several hundred meters within map m where not ice cored. Amphibolite facies metamorphic rocks and Not present. Not present. orthogneiss of tectonic inclusion in McHugh (Unit Mo). Contains local lenses of Although uneven topography, foundations and Permafrost probably present, especially in the unit Only the silt and clayey horizons subject to Forms ridges of kames and elongated, serpentine Distributed as kames and kame terraces in Chugach Washed sand and gravel, ranging from fine sand and mantled with lake deposits (lc/ke) but may be thin and frost action, including the silt mantle of unit eskers with intervening swales and marshy areas. lountains, kames and eskers bordering the Little hornblende biotite diorite, quartz diorit construction. Some eskers and kames provide large sporadic in lateral extent near heat sources such as lc/ke. Remainder of unit in granular materials Ridges are normally well drained, the swales poorly Nelchina River and Lake Louise, and as kame-esker quantities of easily-worked, well-drained gravel gneiss, gabbro, and pyroxenite. Foliation or rounded, sandy matrix, generally less than 6% silponds and lakes. Thickness not known. Little or no is generally non frost-susceptible. drained. Through drainage is poorly intergrated. Soil beneath glaciolacustrine deposits in the Late Louise-Deposits need to be checked for coal and chert before content. Locally contains pieces of coal, lignite or excess ice in granular material to cause differential drainage of unit mantled with lake deposits (lc/ke) is Kame-esker deposits Susitna Lake area. Thickness of deposits probably less use as concrete aggregate. Many deposits of this type shale. Where covered by thin lacustrine deposits with settlement on thawing. than 50 ft (15 m), more likely 10 to 20 ft (3 to 6 m). poor except for unusually sharp ridge crests. have abrupt lateral variation from coarse to relativel little alteration of landforms, mapped as lc/ke. McHugh Complex, a deformed diverse McHugh Complex, a deformed diverse Not present. fine material, and may include local pockets of fros assemblage that has broad discontinuous assemblage that has broad discontinuous susceptible or otherwise unsatisfactory materials. shear zones, and inclusions of marble (Unit shear zones, and inclusions of marble (Unit Mm where mappable). Altered and sheared Mm where mappable). Altered and sheared quartz diorite, diorite, and gabbro, quartz diorite, diorite, and gabbro Frozen, ice-rich, fine-grained deposits require special construction methods to prevent thawing of greenschist, blueschist, aligned in matrix of greenschist, blueschist, aligned in matrix of Wide range of stratified to massive deposits of glacial Underlain by the most continuous and thickest Nelchina River to altitudes as high as 3,200 feet (975 m); to the south upper limit is about 2,500 ft (762 m), phyllite or argillite; chloritic argillite has phyllite or argillite; chloritic argillite has area, or a thin cover that has a topography that permafrost in map area, probably broken only by lakes laid down as mantle over glacial deposits (le/gm, permafrost. Sources of granular borrow are remote hawed zones beneath lakes and larger stream wispy lenses of green tuff, thin bedded wispy lenses of green tuff, thin bedder c/m) and kame-esker deposits (lc/ke). Range from aminated silt, sand, and clay (sand mapped as s where Poor drainage. This map unit, especially lc and lc/gm, is probably the poorest of any for construction, but e principal shoreline (mapped in unit b) being 2,450 kame-esker deposits. Lacustrine deposits are poorly Permafrost thickness generally less than but may siliceous argillite, argillaceous chert, siliceous argillite, argillaceous chert, locally exceed 125 ft (38 m), the greatest known massive and pillowed greenstone, tan and massive and pillowed greenstone, tan and drained and are covered by muskeg and stunted black Glaciolacustrine deposits known), to massive or poorly stratified stony silt, silty ft (747 m). Thickness of lake-bottom deposits probably where underlain by gravelly or sandy material, lc/m only a few m in most places where the short-lived lake permafrost thickness. Ice wedges and masses may be marine chert and wacke sandstone, marine chert and wacke sandstone. gravel (as lenses), sand, and gravel. Much of the nearlc/ke, unit has more favorable foundation, material Pumpellyite-prehnite grade metamorphism. surface material is stony silt (diamicton) with angular ound in these frozen deposits, but most of the ice covered older deposits, the landforms of which are still Pumpellyite-prehnite grade metamorphism. content is thin layers, lenses, and veins that in many preserved. Along Tazlina River and elsewhere in the to rounded stones, sand, and abundant silt and clay, deeper part of the lake basin, sediments mixed with areas exceed the natural voids of the soil; this excess generally poorly stratified. ice will result in ground subsidence upon thaw of the Not present. Marble within McHugh Complex (Unit Mo). Marble within McHugh Complex (Unit Mo). Not present. other material are more than 300 ft (100 m) thick. Not present. Landslide deposits are generally uneven and are locally Silty slide materials susceptible to frost action. Slides should be checked for current and recent Permafrost conditions are unknown. Although a few mafic, and ultramafic igneous rocks in a diorite, and volcanic rocks in a matrix of matrix of cataclasite (chlorite-rich, fine-Form characteristic lobate deposit with steep face at Ranges fault; blocks and crushed matrix of Ranges fault; blocks and crushed matrix of Formed of shale in southeastern Talkeetna Mountains, still moving as shown by living split trees and ground movement, and adjacent areas having the same serpentinized ultramafic rock, rodingite dike serpentinized ultramafic rock, rodingite dike upper Matanuska River tributaries, northernmost rock fragments, mainly derived from bedrock slide with incorporated overburden. Fresh slide very wet, cracking. In general have poor foundations as liquefied geologic conditions should be investigated to grained granular crushed intermediate, melange. mafic, and ultramafic rocks) subsequently rocks, blocks of layered gabbro, croesite schist, pillow basalt, marble, chert. Includes schist, pillow basalt, marble, chert. Includes ugach Mountains and along Glenn Highway east of headwall, usually in rock. Seepage from rock and to deep seated slides that move on failure planes in mud, broken shale, large boulders of hard rock. Poor surface drainage generally forms creek that flows Little Nelchina River. Formed of volcanic and igneous construction sites. conglomerate like that in Chickaloon Formation (Tertiary). Besides prominent Formation (Tertiary), Besides prominent rocks on slopes oversteepened by glaciation in Chugach down slide; slide material partially to wholly liquefied altered by retrograde processes. Landslide deposits near seepages and drainage channels. Mountians, Landslides in unconsolidated deposits are small and generally incorporated in Unit c. Thickness serpentinite is also incompletely serpentinite is also incompletely serpentinized dunite, peridotite, and serpentinized dunite, peridotite, and of large, mappable slides not known, perhaps as much as 65 ft (20 m). Silty material is susceptible to frost action. Construction potential limited by uneven terrain Range from subdued to prominent subparallel ridges on Permafrost may be present, but deposits with excess Not present Tectonic mélange of metabasalt and lesser Not present. Not present. Not present. Loose, poorly-sorted, nonstratified silty sandy gravel, slopes and in lowlands to heavily kettled massive similar to ground moraine (gm) but less compacted and including much stratified sand and gravel, silt, and ice and settlement potential are probably relatively amount of pyroclastic rocks, including those till and gravelly ridges on slopes and hillsides above However, foundation conditions good to fair on ridge: 3,200 ft (975 m); below that level moraines are lateral moraines like those north of Glenn Highway. Talkeetna Formation, in crushe knobs, although commonly frost-susceptible. Relief as much as 80 ft (25 m). Moraines are crossed commonly mantled by lake sediments (lc/m). The most prominent moraines are northwest of Curtis Lake, cataclastic matrix. End-and lateral-moraine deposits Suitable granular borrow locally available. by streams, but much of the drainage is internal oulders are angular to subrounded. west of Little Nelchina River, and between Tolsona through permeable soils. and Tazlina Hills north of Glenn Highway. Thickness unknown, but may be as much as 100 ft (30 m). Andresen and others, 1964 Andresen and others, 1964 Burns and others, 1983 Detterman and others, 1976 Ice, not subject to frost action. Generally poor for construction because of potential Occurs as lateral and medial moraines and as part of Grantz, 1960, 1965 ice matrix enclosing largely angular rock fragments, Grantz, 1961b, 1965 Grantz, 1960, 1961a, 1961b, 1965 Winkler, Silberman, and others, 198 for subsidence on thawing of glacial ice and because of the end moraines of Nelchina, Matanuska, Tazlina and medial moraines; hummocks and collapse pits of icemuch as 100 % of thaw depth, depending on amount of derived from mountainsides and transported as medial Pessel and others, 1981 Pessel and others, 1981 Hawkins, 1976 cored terminal or end moraines. Drainage of melt deformation of foundations by glacier movement. Not and lateral moraines and deposited as ice-cored smaller glaciers in Chugach Mountains. Thickness of Winkler and others, 1984 unpublished Winkler and others, 1984 unpublished a source of materials. Rough terrain prevents use in water and precipitation through crevasses to subglacial Debria-rich glacial ice of medial. moraine. Boulders concentrated at surface by melting deposit not known. mapping mapping and marginal drainage systems. A few glacier-surface local areas as a temporary road. probably more abundant than boulders entrained in ice lateral, and terminal moralnes streams lead to enlarged crevasses (moulins) through Silt content above 6% makes deposits frost Slopes may be moving by gravity creep of talus. Generally not well suited for construction because of Most commonly occurs at the foot of and on lower Angular rock fragments of pebble to boulder size instability of slopes or occurrence of avalanches. which attain slopes of about 100 % at the upper limit deposits in other regions have permafrost that includes embedded in silty sandy matrix; nonstratified and mountain slopes in talus cones and in avalanche chutes Near-surface blocky material may, in hard rock area of the cones, and as little as 10 % at the lower limit, ice masses formed from buried snow banks. poorly sorted, except where locally reworked by in scree slopes on upper mountainsides, and in cirques in Chugaeh Mountains, be suitable for riprap, coarse r toe. Scree slopes exceed 100 % in upper part, and where the deposits may border glaciers or merge Talua and rubble are 20 - 30 % at their lower limit. Drainage elsewhere. Excavation may activate slope movement percolates freely through the coarse materials, and than 50 ft (15 m). Rubble deposits of flat hill summits and gentle slopes (felsenmeer) are frost-split bedrock removes fines from the upper 1.5 ft (0.5 m) as it moves mixed with finer material, that is as much as 15 ft (5 Undesirable for construction because of potential for References cited Permafrost probably is preserved as interstitial ice of Located within high mountain cirques or at the toe of Nonstratified, unsorted mixture of broken angular rock talus cones; outer margin is a near-vertical slope and fragments in silty sandy matrix. Active rock glaciers, talus cones in the southern Talkeetna and northern sufficient to cause differential settlement upon settlement upon thawing of interstitial ice. Alaska Geological Society, 1970, Stratigraphic correlation sections, Copper River Basin, and possibly some farther downvalley that are no Chugach Mountains. Thickness not known, but perhaps Alaska: Anchorage, Alaska, Alaska Geological Society Stratigraphic Committee placiers, a series of 6 - 15 ft. (2 - 5 m) high ridges Rock-glacier deposits longer active, contain intergranular ice or ice that concentric with the frontal scarp of the rock glacier year 1970, 3 sections, vertical scale 1 in.=400 ft. Active rock glaciers are normally those closest to the Alaska Glacial Map Committee of the U.S. Geological Survey, 1965, Map showing extent talus source in the cirque or on slopes, but those of glaciations in Alaska: U.S. Geological Survey Miscellaneous Geologic Investigations Map I-415, 1 sheet, scale 1:2,500,000. viovement is much less than 3 ft (1 m) per year. American Association of State Highway and Transportation Officials (AASHTO), 1982, Normally drainage is internal through the rubble to a Recommended practice for the classification of soils and soil-aggregate mixtures for highway construction purposes, in Standard specifications for transportation eneath the frontal scarp of the rock glacier. materials and methods of sampling and testing, Part I, Specifications adopted by AASHTO, 13th ed., July: Washington, D.C., American Association of State Probably perennially frozen, but no supporting Fine and silty sand containing more than 6% silt Highway and Transportation Officials Designation M145-82, p. 211-217. Well-drained sand deposits are on flat-topped ridges Distributed between Old Man Lake and Lake Louise at elevation 2,450-2,500 ft (747-762 m), where sand forms Fine to medium-coarse sand, apparently a shallows frost-susceptible; medium to coarse sand satisfactory for constructtion; lack of coarser granular Andreasen, G. E., Grantz, Arthur, Zeitz, Isidore, and Barnes, D. F., 1964, Geologic surrounded by lowland marsh and muskeg that is underlain by fine-grained lacustrine deposits (mapped subsurface data are available. The cross sections on this sheet show the subsurface unconsolidated deposits and water facies, perhaps deltaic, of the glaciolacustrine materials and lack of datas on permafrost and subjacent generally not frost-susceptible. interpretation of magnetic and gravity data in the Copper River Basin, Alaska: flat-topped ridges, perhaps these are locally ice-bloc bedrock. A bedrock cross section (A-A') has been based on seven exploratory oil wells materials are drawbackss. Local sources of timber J.S. Geological Survey Professional Paper 316-H, p. 135-153, 2 pls., scale differentiated from glaciolacustrine deposits. Sand deltas in which the sand is less than 15 ft (5 m) thick and test holes, ranging from 2,793 to 8,837 ft (851 to 2,794 m) deep. These wells have defined the local basement rocks (volcanic rocks of lower Jurassic age) over much of the may grade downward into sandy foreset and silty on sandy foreset and silty bottomset beds. Beikman, H. M., 1974, Preliminary geologic map of the southeast quadrant of Alaska: section and apparently were drilled into or through the target formations of upper and pottomset beds; locally mantled with thin lacustrine U.S. Geological Survey Miscellaneous Field Studies Map MF-612, 2 sheets, scale middle Jurassic age without achieving success (Alaska Geological Society, 1970). A cross section (B-B') shows materials exposed in river bluffs along the Nelchina River from Burns, L. E., 1982, Gravity and aeromagnetic modeling of a large gabbroic body near the Eureka Creek to Tazlina Lake. Border Ranges Fault, southern Alaska: U.S. Geological Survey Open-File Report Burns, L. E., Little, T. A., Newberry, R. J., Decker, J. E., and Pessel, G. H., 1983, Preliminary geologic map of parts of the Anchorage C-2, C-3, D-2, and D-3 Proximity to active faults quadrangles, Alaska: Alaska Department of Natural Resources, Division of Ground-water resources Geological and Geophysical Surveys, Report of Investigations 83-10, 3 sheets, scale Seismic design for the Trans-Alaska Pipeline, about 18 mi (29 km) east of the map Suitability of the surficial unconsolidated deposits for contruction materials and Experience in developing ground-water resources along the Glenn Highway for use area provided for magnitude 8.5 within the Chugach Mountains, a magnitude 7.0 in the Chapin, Theodore, 1915, Auriferous gravels of the Nelchina-Susitna region: U.S. foundations is evaluated in the description of map units on sheet 2. The basis for the by residents and businesses suggests that certain general principles apply, modified by Copper River Basin, and a magnitude 8.0 in the vicinity of the Denali fault in the Alaska evaluation is sampling and testing of soils believed reasonably representative of the map Geological Survey Bulletin 622-D, p. 118-130. local conditions and exceptions to the rule. In general, the thin, relatively impermeable Range 70 mi (113 km) north of the map area (Page and others, 1972). Westward Chapin, Theodore, 1918, The Nelchina-Susitna region, Alaska: U.S. Geological Survey units; however, individual beds and lenses within complexly stratified and lenticular glaciolacustrine and glacial deposits and thin glaciofluvial mantle yield no water or only extension of these design criteria earthquakes requires examination by earthquake deposits cannot represent the unit as a whole, as, for example, in pit-run material taken Bulletin 668, 67 p. small supplies to dug or driven wells, but the long period of no recharge and low winter specialists of the faults within the map area and their recent activity, and would seem to Bends in section at each well site, as shown on map sheet Detterman, R. L., Plafker, George, Tysdal, R. G., and Hudson, Travis, 1976, Geology and from a vertical section consisting of many individual beds and lenses of different water table makes many of these wells unproductive in winter. The uppermost bedrock equire a minimum design magnitude of 7.0. The western part of the area, within the characteristics. Not all map units were tested. The conclusions drawn from the data, surface features along part of the Talkeetna segment of the Castle Mountain formation, chiefly relatively impermeable shale, siltstone, and fine, tight sandstone of er Matanuska River valley is bordered by the Border Ranges/Eagle River fault and by Caribou fault system, Alaska: U.S. Geological Survey Miscellaneous Field Studies therefore, are useful only as a general guide for route selection or soil exploration, and he Castle Mountain/Caribou fault (see inset map). The Border Ranges fault passes Map 738, 1 sheet, scale 1:63,360. should not supplant the usual subsurface investigations required by good engineering little or no water to wells. Small supplies have been developed in talus deposits and through the northern Chugach Mountains as a thrust along which the Valdez Group has Eckhart, R. A., 1953, Gypsiferous deposits on Sheep Mountain, Alaska: U.S. Geological practice. The soil tests, including Atterberg limits and mechanical analyses needed to alluvial fans along the slopes of Sheep Mountain, where the water is high in sulfate been moved beneath the older igneous and metasedimentary rocks (MacKevett and Tertiary gravel classify the material were made at only 20 locations, mostly in the fine-grained problem Survey Bulletin 989-C, p. 39-60, 2 pls., scale 1:12,000 and 1:2,650. coming from gypsiferous deposits; this water is highly corrosive to metal pipe. Several Plafker, 1974; Winkler, Silberman, and others, 1981). The fault cuts Tertiary rocks, but Emery, P. A., Jones, S. H., and Glass, R. L., 1985, Water resources of the is believed to have been largely inactive in the last 10,000 yrs; however, displacement o Basin, Alaska: U.S. Geological Survey Hydrologic Investigations Atlas HA-868, 3 permeable lenses or beds. Tertiary gravel is an excellent aquifer where beneath the drift in reports of subsurface testing and sampling for construction or reconstruction of state Upper Cretaceous alus and other Recent deposits has been detected along the fault by Burns and others highways by Alaska Department of Transportation and Public Facilities and its or lacustrine deposits in the valleys, e.g., well 5 (map and section A-A') on Mendeltna marine siltstone, shale Mendeltna Cr. 983) 2.15 to 3.3 mi (3.7 to 5.1 km) east of Matanuska Glacier. Grantz (1965), Andreasen Ferrians, O. J., Jr., 1966, Effects of the earthquake of March 27, 1964, in the Copper Creek where the base of gravel beneath the drift was 583 ft (178 m) below the surface. and others (1964), Detterman and others (1976), and Silberman and Grantz (1984) in probably Tertiary(?) River Basin area, Alaska: U.S. Geological Survey Professional Paper 543-E, p. E1-This aquifer may extend southward in Mendeltna Creek valley to the south side of Fish mapping the Castle Mountain fault and its major branch, the Caribou fault, believe that glacial till. The soils were classified according to American Association of State Lake where a flowing artesian well is located on the south shore (Mrs. C. R. Houston, the system is not seismically active and that movements, if any, are due to lower crust Tertiary - 500m sand and gravel (sandstone and conglomerate) Highway and Transportation Officials (AASHTO, 1982), the classification of soils and Ferrians, O. J., Jr., Nichols, D. R., and Williams, J. R., 1983, Copper River Basin, in oral commun., 1984). The aquifer may have some still-unknown relation to Mendeltna displacements, rather than to surface faulting. These faults are believed to splay into Péwé, T. L., and Reger, R. D., eds., Guidebook to permafrost and Quaternary geology along the Richardson and Glenn Highways between Fairbanks and soil-aggregate mixtures for highway construction purposes. Data were collected by Jomaller faults within the Copper River Basin. Definite evidence of ground slippage in Upper Cretaceous Kubota of the U.S. Department of Agriculture during his 1952 field studies and related Holocene time has been noted in the Matanuska River valley west of the map area, and a 1817 (554m) laboratory work (unpublished), and from samples collected by Kubota and the writer that norage, Alaska: Fourth International Conference on Permafrost, Fairbanks, The Copper River Basin saline aquifer lies generally below 2,000 ft (610 m) above possible active fault segment is located on lower Sanona Creek. No specific seismic Cretaceous | marine shale, siltstone Alaska, July 18-22, 1983. Guidebook 1, Fairbanks, Alaska: Alaska Department of were later analyzed by Bureau of Public Roads, U.S. Department of Commerce, and by sea level, and, for the most part, east of the map area, except for a few gas seeps and possible saline seepages near Tolsona Lake (well 11). Elsewhere most of the well water design criteria have been established as yet for the map area. marine shale, siltstone Natural Resources, Division of Geological and Geophysical Surveys, p. 137-175. the Alaska District, Corps of Engineers, U.S. Army, Anchorage. Upper Cretaceous | shale and siltstone Ferrians, O. J., Jr., and Schmoll, H. R., 1957, Extensive proglacial lake of Wisconsin age and that from Mendeltna Springs is fresh and potable. Saline springs lie immediately eas: Surficial silt and admixed peat and other organic material form a mantle as thick in the Copper River Basin, Alaska (abs.): Geological Society of America Bulletin, v. of Tolsona Creek along both Glenn Highway and Tazlina River (Nichols and Yehle, 1961; as 10 ft (3 m) in poorly drained areas not only on the lacustrine silt, but also in the Grantz and others, 1962). Connate (saline) water was found in lower Cretaceous beds in Slope stability problems are largely a result of glacial oversteepening of slopes during the last and earlier glaciations. Slope failure, chiefly landslides and also rockfalls Lower Cretaceous undrained depressions of moraines, ground moraine, ice-contact deposits, and alluvial Grantz, Arthur, 1956, Possible origin of the placer gold deposits of the Nelchina area, at least one oil well (4, map, and also under pressure in a well drilled by Pan American flood plain and terrace deposits. It is generally classified in group A-5 of AASHTO 1982 Petroleum Corp. at Glennallen east of the map area) (Alaska Geological Society, 1970; Alaska (abs.): Geological Society of America Bulletin, v. 67, no. 12, pt. 2, p. 1807. and avalanches, is not limited to the soft siltstone and shale of the Matanuska Formation classification and has a group index for fine-grained soils that exceeds 20, indicating very Basal Upper Cretaceous 1960, Geologic map of Talkeetna Mountains (A-1) quadrangle, and the south third of poor subgrade materials, whether dried or under natural moisture conditions. Talkeetna Mountains (B-1) quadrangle, Alaska: U.S. Geological Survey sediments (Reitsema, 1979). The water and gas have migrated from bedrock upward 2000 - TD4818 (1468m)/ (unit Sf. map), for other slope failures occur in gabbro, metamorphic rocks, and perhaps Miscellaneous Geologic Investigations Map I-314, 1 sheet, scale 1:48,000. through the unconsolidated deposits to either be discharged from springs and mud have resulted from failure of a rock wedge in an oversteepened slope, the base of which Sand, a constituent of a variety of deposits (map units al, at, b, e, ke, and s) was analyzed at three sites—a lacustrine sand exposed in a river bluff, a kame-esker or 1961a, Geologic map and cross sections of the Anchorage (D-2) and northeasternmost volcanoes, or to become trapped beneath an impermeable bed in the unconsolidated was cut away by the glaciers. The largest area of landslides is on the south slope of Slide Middle (and Upper?) Jurassic part of the Anchorage (D-3) quadrangle, Alaska: U.S. Geological Survey deposits, such as lacustrine silt. The potentiometric surface of the saline aquifer Mountain, where many landslides have occurred since deglaciation; the failures are in deltaic sand, and sand from beneath ground moraine on the summit of the 4,000-for - 6225 (1897m) Miscellaneous Geologic Investigations Map 1-342, 1 sheet, scale 1:48,000. generally slopes eastward and southward toward the incised Copper and Tazlina Rivers, flat-lying Matanuska Formation capped by about 50 ft (15 m) of Tertiary gravel and (1,219-m) hill northwest of Eureka Lodge. The AASHTO classification of these sand 1961b, Geologic map of the north two-thirds of Anchorage (D-1) quadrangle, Alaska: sand. The most recent slide reportedly took place not long before the 1946 inspection by 6625 (2019m) deposits are either group A-2-4(o), A-2, or, where silty, A-4(2). U.S. Geological Survey Miscellaneous Geologic Investigations Map I-343, 1 sheet, saline water could rise in a pipe above ground level; the problems of saline water appear R. F. Black (unpublished U.S. Geological Survey field notes, 1946). Smaller slides in shale limited to the lowlands below 2,000 ft (610 m) elevation along the eastern edge of the are common along East Fork Matanuska River. Slides and earth flows are common in Sand and gravel mixtures are largely within the A-la category of the AASHTO classification. Sand and rounded gravel occurs chiefly in kames and eskers (map unit \underline{ke}), Lower Jurassic volcanics 6470 (1972m) 1965, Geologic map and cross sections of the Nelchina area, south-central Alaska: map area, extending eastward toward Glennallen and Gulkana. Further information may acustrine and colluvial silt and clay and in silty till along streams and on hillsides. Rock U.S. Geological Survey Open-File Report 255, 4 sheets, scale 1:63,360. be obtained from the literature cited and from well inventories by Waller and Selkregg falls and rock avalanches in narrow chutes in steep walled valleys are local hazards. TD6721 ? fluvial deposits (al. at), and beach deposits (b). Other types of gravel are either more Grantz, Arthur, White, D. E., Whitehead, H. C., and Tagg, A. R., 1962, Saline Springs, (1962) and a more recent one made by R. L. Glass and others in support of current Creep on steep slopes in talus and in rock glaciers makes them poor foundations. angular, more silty, or both, and tend toward the A-4 group of the AASHTO system Copper River Lowland, Alaska: American Association of Petroleum Geologists hydrologic studies by Water Resources Division, U.S. Geological Survey (Emery and Middle Jurassic these units include colluvium (map unit c), rock glacier deposits (rg), talus (t), and Bulletin, v. 46, no. 11, p. 1990-2002. ndslide deposits (ls). These units were not sampled and have slope stability problems Hawkins, D. B., 1973, Sedimentary zeolite deposits of the upper Matanuska Valley - 6000 that make them unsuited for many purposes. Sand and gravel, with both angular and Alaska: Alaska Department of Natural Resources, Division of Geological and Other wells among those numbered 8-25 in Waller and Selkregg (1962) are largely Perhaps the most widespread of the geologic hazards is that of permafrost, or TD7913 (2412m) TD8837 (2794m) rounded stones and increasing amounts of silt form the gravelly till or sandy till that is shallow driven points or dug wells in the thin drift that covers the relatively impermeable Geophysical Surveys, Special Report 6. perennially frozen ground. In the map area, it is discontinuously distributed, but is common in the morainal deposits (unit m), but rarer in the ground moraine (gm) and Vertical scale 1976a, Mordenite deposits and zeolite zonation in the Horn Mountain area, southupper Cretaceous shale and siltstone or the much more permeable Tertiary sandstone and present in most areas except beneath the larger lakes or streams, or in some cases glaciolacustrine diamicton included in unit le; some of these are in AASHTO Group A-4, central Alaska: Alaska Department of Natural Resources, Division of Geological beneath coarse gravelly material through which water percolates readily. Depth of CROSS SECTION AAI ACROSS SOUTHWESTERN PART OF THE COPPER RIVER BASIN, ALASKA and Geophysical Surveys, Special Report 9, 9 p., 2 pls., scale 1:21,120. are frost susceptible, and may contain segregated ice where perennially frozen. modified from Alaska Geological Society (1970). Quaternary deposits not shown about mile 3 (4.8 km) on the Lake Louise Road; it has a log similar to that in nearby ermafrost below the land surface known from only a few wells (table) is about 80 to 100 1976b, Commercial grade mordenite deposits of the Horn Mountains, south-central Union Oil Tazlina Unit No. 1 (well 6, cross section AA'); the base of permafrost was 100 t (25 to 30 m), and one well in which permafrost is 125 ft (38 m) deep; these depths are Alaska: Alaska Department of Natural Resources, Division of Geological and Lacustrine and fluvial silt and clay and stone-poor diamicton (unit lc) have been ft (30 m) deep in the Army well. Other dry holes at mile 130, 126, 135 Glenn Highway red to maximum depths of 150 to 250 ft (46 to 76 m) in river bank exposures and classed as AASHTO Group A-4 where the deposit is of sand and silt mixtures, and A-6 or between Sheep Mountain and Little Nelchina River apparently bottomed in tight shale or Geophysical Surveys, Special Report 11, 11 p., 1 pl., scale 1:15,840. 100 to 200 ft (30 to 61 m) in wells (Nichols, 1956, p. 8) near Glennallen, east of the map A-7 where it is of silt and clay mixtures. The Group Index (AASHTO, 1982) for fine-MacKevett, E. M., Jr., and Plafker, George, 1974, The Border Ranges fault in southsiltstone (R. L. Glass, U.S. Geological Survey, written commun., 1984). area. Permafrost (near Glennallen) has a temperature of about 30°F (-1°C) at the level central Alaska: U.S. Geological Survey Journal of Research, v. 2, no. 3, p. 323-329. of zero annual amplitude (Nichols, 1966, p. 173), and, at that temperature, it is very grained soils is greater than 20 for the very plastic varved clay and silt within unit le in Martin, G. C., and Mertie, J. B., Jr., 1914, Mineral resources of the upper Matanuska and easily thawed by slight changes in the ground surface temperature brought on by Nelchina Valleys: U.S. Geological Survey Bulletin 592-H, p. 273-299 alteration of the surface conditions, as, for example, by clearing the vegetation. Much mouth, and of Nelchina River above the mouth of Little Nelchina River; these materials Miller, R. J., Winkler, G. R., O'Leary, R. M., and Cooley, E. F., 1982, Analyses of rock, Subsurface data of the permafrost in fine-grained deposits contains excess ice as lenses, veins, and small are a very poor subgrade, and, in addition, contain excess ice as lenses and veins which (see also cross sections on sheet 2 stream sediment, and heavy-mineral concentrate samples from the Valdez masses, including wedges. Thawing of this excess ice causes ground settlement. The cause differential settlement of the material upon thawing of the permafrost. Where the quadrangle, Alaska: U.S. Geological Survey Open-File Report 82-451, 224 p., 2 pl., amount of subsidence depends on the quantity of ice in excess of the natural voids in the Group Index is less than 20, fine-grained soils may be suitable foundations with prope Remarks and other information materials. The silty sediments locally are thick enough and contain enough excess ice to Nichols, D. R., 1956, Permafrost and ground-water conditions in the Glennallen area, cause settlements of at least 3 ft (1 m); normally, however, the ice-rich material is less that settlement will take place on thawing of the ground during or following construction Alaska: U.S. Geological Survey Open-File Report, 14 p., 2 pls. than 20 ft (6 m) thick, and settlement is several inches but may in some areas exceed a 1-6 All information on cross section A-A', No data on permafrost. 1966, Permafrost in the Recent Epoch: Permafrost International Conference, 11-15 foot. The character of permafrost in each map unit is given in the description of November, 1963, Lafayette, Indiana, Proceedings: Washington, D.C., National Academy of Sciences—National Research Council Publication 1287, p. 172-175. Glacial till generally falls in AASHTO classification A-4, and has a generally low surficial deposits map units. Group Index indicating that it may, with good drainage and proper compaction be a 7-9 30.5 Chiefly glacial drift and silty Frozen to about 20 m. Nichols, D. R., and Yehle, L. A., 1961, Mud volcanoes in the Copper River Basin, Alaska, Avalanches on talus slopes and floods on fans suitable subgrade material. The till of map unit gm and some of that of unit m falls in sandy and gravelly material of in Raasch, G. O., ed., Geology of the Arctic: Toronto, University of Toronto Press, this category. The till-like glaciolacustrine diamicton, landslide deposits, talus, and Tertiary age, with lowermost few In addition to rock avalanches at any time of year, many avalanche chutes above other units may be more silty, or even more gravelly, to warrant a higher or lower Nichols, D. R., and Yehle, L. A., 1969, Engineering geologic map of the southeastern m possibly shale of upper Cretatalus cones are the site of springtime avalanches of snow and rock debris which sweep all Copper River Basin, Alaska: U.S. Geological Survey Miscellaneous Geologic Investigations Map I-524, 1 sheet, scale 1:125,000. ceous age. Tertiary rocks before them and commonly block passage at the foot of the hill in the accumulation area. Avalanches can be identified sometimes by the scarred, matted, and broken down Very few engineering data have been collected on bedrock. The most common Page, R. A. Boore, D. M., Joyner, W. B., and Coulter, H. W., 1972, Ground motion values up hill to summit north of highappearance of the vegetation. They are particularly common in the glaciated Chugach for use in the seismic design of the Trans-Alaska Pipeline System: U.S. Geological fountains, and less common in the more gently sloping terrain of the Talkeetna Sm), volcanic flows and pyroclastic rocks (map unit Vu), and sandstone and omerate (unit Sc) which contains deleterious amounts of chert and coal. The shale 0-37 m lacustrine silt, sand, Coal beds reported as thick Pessel, G. H., Henning, M. W., and Burns, L. E., 1981, Preliminary geologic map of parts 2300 is baked and indurated west of Eureka Lodge and has been used extensively for road fill gravel (outwash or ice contact) as 1.5 m. No water at total. of the Anchorage C-1, C-2, D-1, and D-2 quadrangles, Alaska: Alaska Department Alluvial fans in the Chugach Mountains are formed by small tributary streams To the east the shale is soft and fails in large landslides under favorable conditions on and some basal till; 37-51 m depth. Frozen 0-5 m. of Natural Resources, Division of Geological and Geophysical Surveys, Open-File which are subject to torrential floods and to frequent channel shifting following heavy slopes that have been oversteepened by glacial erosion, as at Slide Mountain. Nearby, at poorly consolidated sandstone Report AOF-121, 1 sheet, scale 1:63,360. rain or snowmelting. Those in the less rugged Talkeetna Mountains seem to have more the Little Nelchina River crossing some difficulty was encountered in reaching refusal of gravel, sand or sandstone, coal; Post, Austin, and Mayo, L. R., 1971, Glacier-dammed lakes and outburst floods in stable stream courses, a lower gradient, and perhaps a greater drainage basin storage 2200 bridge piling driven in the soft shale. The rock in adjacent roadcuts is still sliding and has caused unending maintenance problems. Tests of a bulk sample of this shale from the Alaska: U.S. Geological Survey Hydrologic Investigations Atlas HA-455, 2 sheets, capacity in the vegetated slopes than those of the Chugach Mountains. Nevertheless, Profile along thalweg of Ne/c _ 650m high rainfall during summer storms can cause devastating floods. eastern end of the old (1952) bridge by the laboratory at Alaska District U.S. Army Corps 0-21 m frozen gravelly material; Gas at base of frozen ground of Engineers (W. M. Knoppe, written commun., December 1952) indicated a density of Reitsema, R. H., 1979, Gases of mud volcanoes in the Copper River Basin, Alaska: 112.6 lb/ft5, specific gravity of 2.6, moisture content of 11%, and saturated CBR of 109 Geochimica et Cosmochimica Acta, v. 43, no. 2, p. 183-187. at 1/10 in, and 6% at 2/10 in, and swell of 2.4%. After drying the density was 116.2 EXPLANATION Silberman, M. L., and Grantz, Arthur, 1984, Paleogene volcanic rocks of the Matanuska ?-79 m shale/siltstone of upper Reported frozen to 24 m Cretaceous age; thin cover of The glaciers of the Chugach Mountains within the map area are not known to be of Valley area and the displacement history of the Castle Mountain fault, in Coonrad. 7.2%. Los Angeles Abrasion Test of fresh material showed grading "A", Wear 38% at 500 W. L., and Elliott, R. L., eds., The United States Geological Survey in Alaska: the surging type. Nelchina and Tazlina Glaciers are each bordered by two ice-dammed revolutions. Dried lumps were pulverized; the material had 60% passing the 0.075 mm Accomplishments during 1981: U.S. Geological Survey Circular 868, p. 82-86. lakes which drain periodically through the ice to cause outburst floods. These sudden size, liquid limit of 39, plasticity index of 15, and was classified as CL under the Corps o - 600m Waller, R. M., and Selkregg, L. F., 1962, Data on wells and springs along the Glenn outbursts of water carried small pieces of ice from Tazlina Glacier to the lake and raised the level of the 60 mi² (155 km²) lake 5 ft (1.5 m) overnight (C. R. Houston, written - 600m 0-25 m frozen gravel and muck; Frozen to 25 m Engineers system. The pulverized shale is in Group A-6 (AASHTO, 1982) and has a Group Highway (State 1), Alaska: U.S. Geological Survey in cooperation with Alaska Index of 7, probably marginal as a subgrade material if properly drained and compacted Lacustrine silt and Imbricated fluvial gravel Sandy topset and commun., 1984). These floods, as reflected in the gaging record on Tazlina River at the Department of Health and Welfare, Basic Data Report, Water-Hydrological Data and if not frozen with excess ice to cause differential settlement upon thawing. Lump 14 78.3 0.6-5.2 m silty gravel; 5.2- Frozen 5.2 m to 38.1 m No. 15, 23 p., 1 pl. Richardson Highway bridge, do not happen every year, may take place twice during a foreset delta beds diamicton, boulders, topset beds of shale, so common in the sand and gravel of the alluvial deposits north of the Chugach Williams, J. R., 1970, Ground water in the permafrost regions of Alaska: U.S. Geological 3.7 m frozen silt and sand; year, generally happen in late July or August, and may be triple the normal summer Survey Professional Paper 696, 83 p. Mountains have caused the alluvium to fail the magnesium-sulfate-soundness test fo bottomset beds 3.7-38.1 m frozen gravel; 38.1discharge to more than 60,000 ft³/sec (2,000 m³/sec) (Post and Mayo, 1971). The four during 1964 concrete aggregate. Similarly, the chert and coal of Tertiary rocks have been surficial map units same as on map sheet 1 1984, Late Wisconsin glacial retreat and lake levels, western Copper River Basin, 78.0 m clay and hardpan; 78.0 ice-dammed lakes drain in different sequence in different years, sometimes in pairs, as earthquake redistributed in some unconsolidated deposits and may cause the deposits to be unsuitable Alaska (abs.): Geological Society of America, Cordilleran Section, 80th meeting on Tazlina Glacier in 1962, or in some years not at all. Post and Mayo suggested that the 78.3 m gravel, water Anchorage, Alaska, May 30, 31, June 1, 1984, Abstracts with Programs, v. 16, no. 5, peak discharge of 1962 was caused by simultaneous drainage of the two lakes bordering vertical exaggeration x 52.8 0-25.9 m glacial capping, muck Permafrost conditions not Tazlina p. 340, abstract 47,109. Collapsed sand and Glacial drift, largely ground moraine Williams, J. R., and Ferrians, O. J., Jr., 1961, Late Wisconsin and Recent history of the and wash; 25.9-26.1 m wash grav- recorded. Location on claim increase in discharge correlable with an outburst flood was detected, so the gradual Geologic hazards and special problems gravel, some silt of seperate glaciations, above and Matanuska Glacier, Alaska: Arctic, v. 14, no. 2, p. 83-90. 1: 26.1-29.6 m silt: 29.6- 19 below discovery is approx release of water must have been further damped by storage in Tazlina Lake. Th Williams, J. R., and Johnson, K. M., compilers, 1980, Map and description of late Tertiary 1700 32.3 m blue-gray gravel, quartz, imate (Chapin, 1918, p. 61). reported 5-ft increase in level of Tazlina Lake is an increase in storage that is just about below deltaic gravel, sand and silt Earthquakes, proximity to active faults, slope stability problems, permafros and Quaternary deposits, Valdez quadrangle, Alaska: U.S. Geological Survey Openequal to the amount of water drained from the two lakes bordering Tazlina Glacier basaltic lava, no sediment, few avalanches, glacial lake "dumping" to raise lake levels and cause drastic increases in These lakes have an aggregate area of 2.7 mi² (4.5 km²) an estimated average depth over File Report 80-892-C, 2 sheets, scale 1:250,000. colors of gold; 32.3-35.9 m, vegeriver discharge and stage are among the hazards and special problems. Williams, J. R., and Johnson, K. M., 1981, Surficial deposits map of the Valdez table muck, willow twigs; 35.9that area of 110 ft (34 m) when full. Simultaneous impact of drainage of all four lakes on quadrangle, Alaska, in Albert, N. R. D., and Hudson, Travis, eds., The United States 36.6 m gravel; 36.6-41.1 m vegethe level of Tazlina Lake and the resulting peak discharge of Tazlina River might, if Geological Survey in Alaska: Accomplishments during 1979: U.S. Geological table muck, gas-bearing (ignited); coincident with glacier-melt maximum discharge of the Copper River, affect structures Survey Circular 823-B, p. B76-B78. along the Copper River downstream from the mouth of the Tazlina River. In July 1932 41.1-43.5 m blue-gray gravel; Earthquakes are common in southern Alaska, and many have been felt in the Winkler, G. R., Miller, R. J., Mackevett, E. M., Jr., and Holloway, C. D., 1981, Map and summary table describing mineral deposits in the Valdez quadrangle, southern the railway bridge across the Copper River at Chitina was destroyed by high water 43.5-45.5 m yellow gravel; 45.5-Copper River Basin. None on record was so severe as the 8.4 magnitude earthquake of 48.5 m clean wash, no sediment augmented by a breakout flood on the Tazlina (Post and Mayo, 1971). March 27, 1964. The southern border of the area is only 35 mi (56 km) north of the Alaska: U.S. Geological Survey Open-File Report 80-892-B, 1 sheet, scale epicenter of this earthquake. Seismic shaking, landsliding, ground cracking and other effects described by Ferrians (1966) caused slight to moderate damage to facilities. The Winkler, G. R., Silberman, M. L., Grantz, Arthur, Miller, R. J., and MacKevett, E. M., CROSS SECTION BB' ALONG NELCHINA RIVER, EUREKA CREEK TO TAZLINA LAKE land subsided 3 ft (1 m) at the southern edge of the area, nearest the epicenter, 2 ft (0.6 Jr., 1981, Geologic map and summary geochronology of the Valdez quadrangle, southern Alaska: U.S. Geological Survey Open-File Report 80-892A, 2 sheets, scale

m) near Sheep Mountain, 1 ft (0.3 m) along Glenn Highway, and 0 ft along the northern border of the area (Ferrians, 1966, fig. 4). Local subsidence of the free face of fan deltas in large lakes, such as Tazlina Lake, caused large waves to cast lake ice high up on the shores. The most badly damaged building was a house that slid off its foundations toward a lake near Mile 160 Glenn Highway. Intensive ground cracking and ejection of water and fine sediment was noted on most alluvial deposits within 100 mi (161 km) of

by waves generated by slumping of deltas.